Write your name here

Surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number | | | | | |

Candidate Number | | | | |

Chemistry

Advanced Subsidiary

Paper 1: Core Inorganic and Physical Chemistry

Sample Assessment Materials for first teaching September 2015

Time: 1 hour 30 minutes

Paper Reference

8CH0/01

You must have:
Data Booklet
Scientific calculator, ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- You may use a scientific calculator.
- For questions marked with an *****, marks will be awarded for your ability to structure your answer logically showing the points that you make are related or follow on from each other where appropriate.
- A Periodic Table is printed on the back cover of this paper.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.
- Show all your working in calculations and include units where appropriate.

Turn over ▶

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S 4 7 5 5 1 A 0 1 2 8

PEARSON

Answer ALL questions.

Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒.
If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Many elements in the Periodic Table have different isotopes.

(a) What is meant by the term **isotopes**, with reference to sub-atomic particles?

(2)

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(b) A radioactive compound containing the phosphide ion, $^{32}P^{3-}$, is used in the treatment of skin cancer.

What is the electronic configuration of the phosphide ion, $^{32}P^{3-}$?

(1)

☒ **A** $1s^2 2s^2 2p^6 3s^2$

☒ **B** $1s^2 2s^2 2p^6 3s^2 3p^3$

☒ **C** $1s^2 2s^2 2p^6 3s^2 3p^6$

☒ **D** $1s^2 2s^2 2p^6 3s^2 3p^3 3d^3$

(c) A sample of silicon contains 92.2% ^{28}Si and 4.67% ^{29}Si, the remainder being ^{30}Si.

Calculate the relative atomic mass of silicon in this sample, giving your answer to an appropriate number of significant figures.

(2)

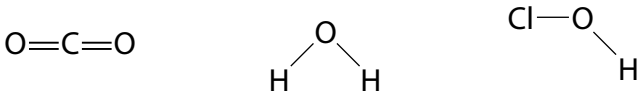
(d) Silicon tetrachloride, $SiCl_4$, is a covalent substance which is a liquid at room temperature.

Calculate the number of molecules in 5.67 g of $SiCl_4$.

(2)

(Total for Question 1 = 7 marks)

2 The molecules carbon dioxide, water and chloric(I) acid can be represented by these structures.



All the bonds in these molecules are polar because the elements have different electronegativities.

(a) In terms of atomic structure, give **two** reasons why oxygen is more electronegative than carbon.

(2)

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(b) Explain why carbon dioxide is the only non-polar molecule of the three.

(2)

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(c) The diagram shows the structure of a water molecule and of a chloric(I) acid molecule.

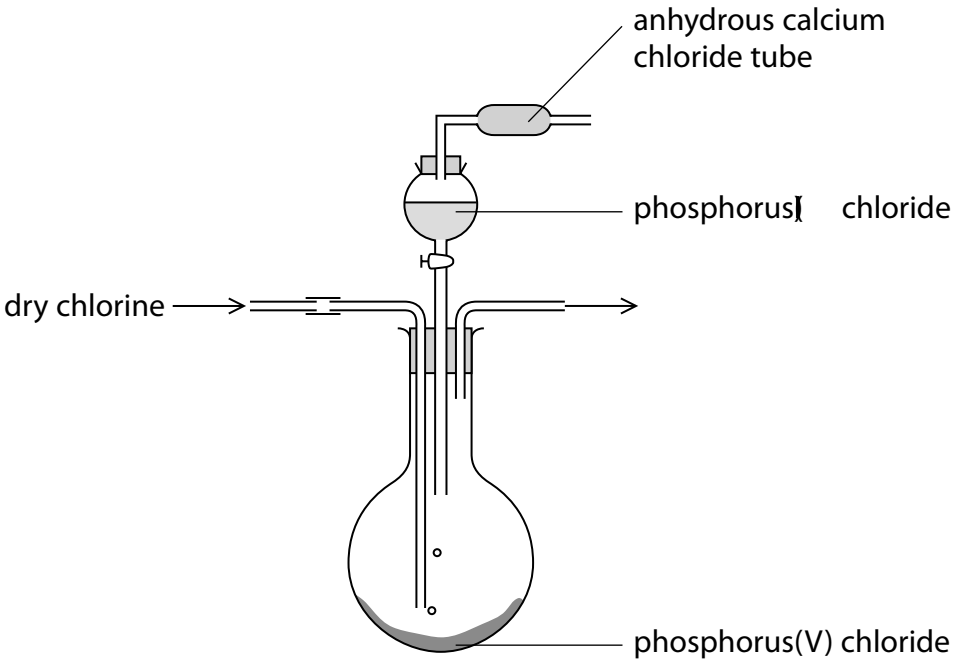
Draw a diagram to show how a hydrogen bond can form between the two molecules.

(2)

(Total for Question 2 = 6 marks)

3 Phosphorus(V) chloride, PCl_5, is a pale yellow solid which sublimes when heated.

Phosphorus(V) chloride may be prepared in the laboratory from dry phosphorus(III) chloride and dry chlorine, using the apparatus shown.



(a) Which statement gives a reason why phosphorus(V) chloride has a higher melting temperature than phosphorus(III) chloride?

(1)

- ☒ **A** PCl_5 contains phosphorus with a higher oxidation number
- ☒ **B** PCl_5 has stronger intermolecular forces
- ☒ **C** PCl_5 molecules have more covalent bonds
- ☒ **D** PCl_5 molecules have stronger covalent bonds

(b) (i) Explain an essential safety precaution for this preparation.

(2)

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(i) The reaction is exothermic.

Explain how the apparatus could be altered to maximise the formation of the product.

(2)

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(ii) Write an equation for the reaction between phosphorus(III) chloride and chlorine. State symbols are not required.

(1)

(c) 4.17 g of phosphorus(V) chloride is reacted with ethanedioic acid, $H_2C_2O_4$, to form phosphorus oxychloride as shown by the following equation:

$$PCl_5(s) + H_2C_2O_4(s) \rightarrow POCl_3(l) + 2HCl(g) + CO_2(g) + CO(g)$$

The phosphorus oxychloride is then hydrolysed by water as shown by the following equation:

$$POCl_3(l) + 3H_2O(l) \rightarrow H_3PO_4(aq) + 3HCl(g)$$

Calculate the total volume, in dm^3, of hydrogen chloride gas produced by both reactions.

[1 mol of any gas occupies 24.0 dm^3 at room temperature and pressure.]

(3)

(Total for Question 3 = 9 marks)

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4 This question is about disproportionation reactions.

(a) Solutions containing chlorate(I) ions can be used as household bleaches and disinfectants.
These solutions decompose on heating as shown by the following equation:

$$3ClO^-(aq) \rightarrow ClO_3^-(aq) + 2Cl^-(aq)$$

What is the oxidation number of chlorine in each of these three ions?

(1)

	ClO^-	ClO_3^-	Cl^-
☒ **A**	+1	+3	–1
☒ **B**	–1	+3	+1
☒ **C**	–1	+5	+1
☒ **D**	+1	+5	–1

(b) A coin, of mass 5.00 g, contains silver. The coin is dissolved in 500 cm^3 of concentrated nitric acid to form silver nitrate solution, $AgNO_3(aq)$.

50.0 cm^3 of this solution is reacted with excess sodium chloride solution to form a precipitate of silver chloride, AgCl.

$$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$$

After filtering and drying, the mass of the precipitate was 0.617 g.

Calculate the percentage by mass of silver in the coin. Give your answer to an appropriate number of significant figures.

(4)

(c) Silver nitrate reacts with iodine as shown by the following equation:

$$6AgNO_3(aq) + 3I_2(aq) + 3H_2O(l) \rightarrow AgIO_3(aq) + 5AgI(s) + 6HNO_3(aq)$$

The reaction is classified as a disproportionation reaction.

(i) What is meant by the term **disproportionation**?

(2)

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(ii) Deduce the element undergoing disproportionation in this reaction.

(1)

☒ **A** Ag

☒ **B** H

☒ **C** I

☒ **D** O

(Total for Question 4 = 8 marks)

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5 Compounds of Group 1 and Group 2 elements show trends in their properties.

(a) Which block of the Periodic Table contains the Group 2 elements?

(1)

- ☒ **A** *s*
- ☒ **B** *p*
- ☒ **C** *d*
- ☒ **D** *f*

(b) Some rocks contain the compound strontium carbonate, $SrCO_3$.

(i) Which of the following could represent successive ionisation energies, in kJ mol^{-1}, for the Group 2 element strontium (Sr) ?

(1)

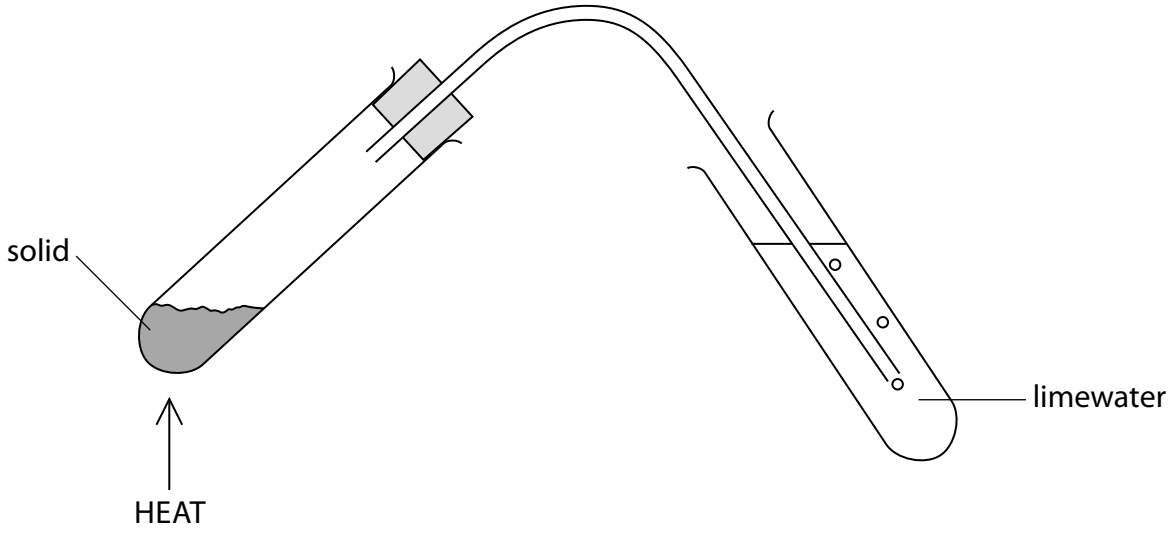
- ☒ **A** 1350 2370 3560 5020
- ☒ **B** 400 2650 3850 5110
- ☒ **C** 550 1060 4120 5440
- ☒ **D** 640 1180 1980 6000

(ii) Write an equation to show the decomposition of strontium carbonate on heating.

Include state symbols.

(2)

(ii) A student compares the rate of thermal decomposition of some Group 1 and Group 2 carbonates using the apparatus shown.



The student tried to keep the temperature of heating approximately constant by using a Bunsen burner with the same settings. The time taken for the limewater to go cloudy is shown in the table.

Sample	Formula of carbonate	Time taken for limewater to turn cloudy / s
A	$CaCO_3$	40
B	$MgCO_3$	20
C	K_2CO_3	does not decompose
D	Li_2CO_3	35

Discuss how the student can use observations from the experiment, and knowledge of the cations present in the carbonates, to justify the relative rate of decomposition.

(6)

(Total for Question 5 = 10 marks)

6 Ammonium carbamate can be used to make urea, a fertilizer. Ammonium carbamate has the empirical formula $CH_6N_2O_2$.

(a) Ammonium carbamate contains 15.38% carbon, 7.69% hydrogen and 35.90% nitrogen by mass. The remainder is oxygen.

Show that the empirical formula of ammonium carbamate is $CH_6N_2O_2$.

(3)

(b) Ammonium carbamate is an ionic compound of formula $H_2NCOONH_4$.
It contains ammonium ions, NH_4^+, and carbamate ions, H_2NCOO^-.
When heated, ammonium carbamate decomposes to release ammonia and carbon dioxide.

(i) Write the balanced equation to show the decomposition of ammonium carbamate into ammonia and carbon dioxide. State symbols are not required.

(1)

(ii) What is the shape of the ammonia molecule, NH_3?

(1)

☒ **A** pyramidal

☒ **B** tetrahedral

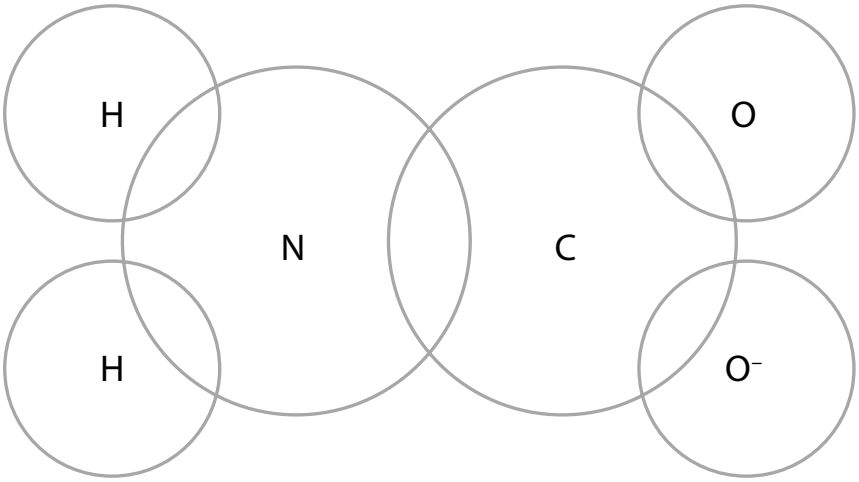
☒ **C** trigonal planar

☒ **D** V-shaped

(ii) Complete the dot-and-cross diagram for the carbamate ion, H_2NCOO^-.

Use dots (●) for the N electrons, crosses (×) for both H and C electrons, circles (○) for O electrons and the symbol Δ for the extra electron on the O^-.

(2)



(v) Deduce the shape of the carbamate ion around the carbon atom. Justify your answer.

(3)

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(Total for Question 6 = 10 marks)

7 This question is about Group 7 and redox chemistry.

(a) Explain the trend in the boiling temperatures of the elements on descending Group 7, from fluorine to iodine.

(4)

(b) Which element in Group 7 has the highest first ionisation energy?

(1)

- ☒ **A** iodine
- ☒ **B** bromine
- ☒ **C** chlorine
- ☒ **D** fluorine

(c) When concentrated sulfuric acid, H_2SO_4, is added to solid sodium bromide, the acid reacts to form a mixture of products, including sulfur dioxide, SO_2, and bromine, Br_2.

The conversion of bromide ions to bromine is shown by the half-equation:

$$2Br^- \rightarrow Br_2 + 2e^-$$

In parts (c)(i) and (ii) state symbols are not required.

(i) Write a half-equation to show the formation of SO_2 from H_2SO_4.

(1)

(ii) Hence write an overall equation for the reaction of Br^- ions with H_2SO_4.

(1)

(iii) Deduce the role of Br^- ions in the reaction in (c)(ii)

(1)

(d) A student compares the reaction of solid sodium chloride and solid sodium iodide with concentrated sulfuric acid by adding 1 cm^3 of acid to separate samples of the solid halides in test tubes.

(i) The reaction between solid sodium chloride and concentrated sulfuric acid produces steamy fumes. Identify the product responsible for this observation.

(1)

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(ii) Solid sodium iodide also reacts with concentrated sulfuric acid. Steamy fumes are produced initially, but a second reaction then takes place.

Give an observation that you would expect the student to make in this second reaction, and write appropriate equations to show the overall reaction taking place.

State symbols are not required.

(3)

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(iii) Explain, in terms of the redox reactions occurring, why the solid halides form different products with concentrated sulfuric acid.

(2)

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(Total for Question 7 = 14 marks)

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8 A sample of trichloroethanoic acid was supplied to a laboratory by a chemical manufacturer. A technician at the laboratory was asked to check whether the percentage purity by mass of the acid was 99.9% as claimed on the label.

The technician used a titration method to determine the purity of the acid. The technician followed this method:

- The technician placed an empty glass bottle on a balance
- After zeroing the balance, the technician added a sample of trichloroethanoic acid to the bottle
- The technician recorded the balance reading, accurate to 1 d.p., as 6.2 g
- The technician transferred the acid to a beaker and dissolved the acid in a small volume of distilled water
- The technician poured this solution into a 250 cm^3 volumetric flask and made the solution level up to the mark with distilled water
- The technician filled a burette with the acid solution
- Using a pipette, 25.0 cm^3 of 0.130 mol dm^{-3} sodium hydroxide solution was transferred to a conical flask
- Several 25.0 cm^3 samples of the sodium hydroxide solution were titrated with the acid solution and the results were recorded.

Results

	Titration numbers				
	1	**2**	**3**	**4**	**5**
Burette reading (final)/ cm^3	23.15	45.40	22.45	45.20	22.20
Burette reading (initial)/ cm^3	0.00	23.15	0.15	22.50	0.00
Titre/cm^3					
Concordant titres (✓)					

Table 1

(a) Complete Table 1 and hence calculate the mean titre in cm^3.

(2)

(b) Trichloroethanoic acid has the formula CCl_3COOH.

The equation for the reaction with sodium hydroxide is:

$$CCl_3COOH(aq) + NaOH(aq) \rightarrow CCl_3COONa(aq) + H_2O(l)$$

(i) Calculate the concentration of trichloroethanoic acid in **g dm^{-3}**. Give your answer to one decimal place.

(3)

(i) Show, using a calculation, that the percentage purity of trichloroethanoic acid is less than that claimed by the manufacturer.

(2)

(c) The uncertainties for the measurements made in this experiment were as follows.

Measurement	Uncertainty	Percentage error (%)
Each mass reading / g	± .05	
Volumetric flask volume / cm^3	± .5	0.200
Pipette volume / cm^3	± .04	
Each burette reading / cm^3	± .05	0.449

(i) Complete the table.

(1)

(i) The total percentage error for the experiment can be estimated by adding together the four percentage errors.

Explain whether the manufacturer's claim that the acid is 99.9% pure is correct.

Use your answer to (b)(i) and the total percentage error for this experiment.

(2)

(d) Identify **three** issues with the technician's method and for each issue identify an improvement.

(6)

(Total for Question 8 = 16 marks)

TOTAL FOR PAPER = 80 MARKS

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The Periodic Table of Elements

1	2											3	4	5	6	7	0 (8) (18)
							1.0 H hydrogen 1										4.0 He helium 2
(1)	(2)											(13)	(14)	(15)	(16)	(17)	
6.9 Li lithium 3	9.0 Be beryllium 4											10.8 B boron 5	12.0 C carbon 6	14.0 N nitrogen 7	16.0 O oxygen 8	19.0 F fluorine 9	20.2 Ne neon 10
23.0 Na sodium 11	24.3 Mg magnesium 12	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	27.0 Al aluminium 13	28.1 Si silicon 14	31.0 P phosphorus 15	32.1 S sulfur 16	35.5 Cl chlorine 17	39.9 Ar argon 18
39.1 K potassium 19	40.1 Ca calcium 20	45.0 Sc scandium 21	47.9 Ti titanium 22	50.9 V vanadium 23	52.0 Cr chromium 24	54.9 Mn manganese 25	55.8 Fe iron 26	58.9 Co cobalt 27	58.7 Ni nickel 28	63.5 Cu copper 29	65.4 Zn zinc 30	69.7 Ga gallium 31	72.6 Ge germanium 32	74.9 As arsenic 33	79.0 Se selenium 34	79.9 Br bromine 35	83.8 Kr krypton 36
85.5 Rb rubidium 37	87.6 Sr strontium 38	88.9 Y yttrium 39	91.2 Zr zirconium 40	92.9 Nb niobium 41	95.9 Mo molybdenum 42	[98] Tc technetium 43	101.1 Ru ruthenium 44	102.9 Rh rhodium 45	106.4 Pd palladium 46	107.9 Ag silver 47	112.4 Cd cadmium 48	114.8 In indium 49	118.7 Sn tin 50	121.8 Sb antimony 51	127.6 Te tellurium 52	126.9 I iodine 53	131.3 Xe xenon 54
132.9 Cs caesium 55	137.3 Ba barium 56	138.9 La* lanthanum 57	178.5 Hf hafnium 72	180.9 Ta tantalum 73	183.8 W tungsten 74	186.2 Re rhenium 75	190.2 Os osmium 76	192.2 Ir iridium 77	195.1 Pt platinum 78	197.0 Au gold 79	200.6 Hg mercury 80	204.4 Tl thallium 81	207.2 Pb lead 82	209.0 Bi bismuth 83	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86
[223] Fr francium 87	[226] Ra radium 88	[227] Ac* actinium 89	[261] Rf rutherfordium 104	[262] Db dubnium 105	[266] Sg seaborgium 106	[264] Bh bohrium 107	[277] Hs hassium 108	[268] Mt meitnerium 109	[271] Ds darmstadtium 110	[272] Rg roentgenium 111							

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

Elements with atomic numbers 112-116 have been reported but not fully authenticated

* Lanthanide series

* Actinide series

140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	[147] Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	163 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
232 Th thorium 90	[231] Pa protactinium 91	238 U uranium 92	[237] Np neptunium 93	[242] Pu plutonium 94	[243] Am americium 95	[247] Cm curium 96	[245] Bk berkelium 97	[251] Cf californium 98	[254] Es einsteinium 99	[253] Fm fermium 100	[256] Md mendelevium 101	[254] No nobelium 102	[257] Lr lawrencium 103